Bargaining and Power in Networks

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Roadmap

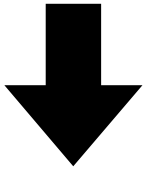
- Power in Social Networks
- Experimental studies of Power and Exchange
- Results of Network Exchange experiments
- Modeling Two-Person Interaction
  - Nash Bargaining solution
  - Ultimatum Game
- Modeling Network Exchange
  - Stable Outcomes
  - Balanced Outcomes

Power in Social Networks

Question: Is power a property of individuals or is it a property of network structure?

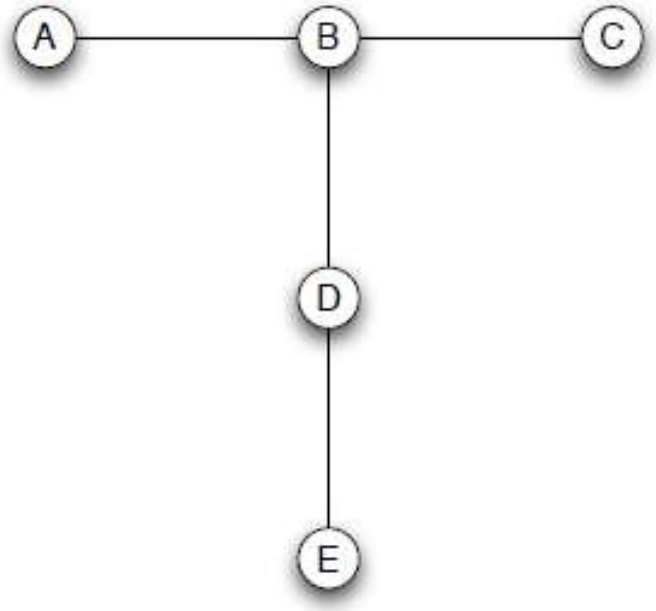
View social relations between two individuals as producing **value** for both of them.

The way in which the value is divided between parties can be viewed as a **social exchange**.



Power corresponds to the imbalance of the division

Powerful Network Position: Example



Principles

- Dependence
- Exclusion
- Satiaton
- Betweenness

Experiments on Power and Exchange

Set-up

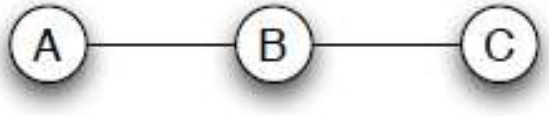
1. **People** are placed at the nodes of a graph
2. Fixed sum of **money** is placed on each edge

Each person **individually negotiates with each of his neighbours**

Each person can perform a **limited number of exchanges**

Four basic networks

(a) *2-Node Path*

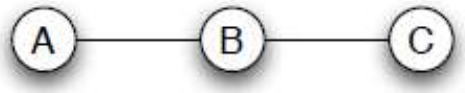


(b) *3-Node Path*

(c) *4-Node Path*

(d) *5-Node Path*

3-Node Path



- Node B intuitively has power over both A and C
- Exluded subjects tend to ask for **less** in the next round in the hope of becoming **included**
- Node B indeed receives the overwhelming majority of the money in his exchanges

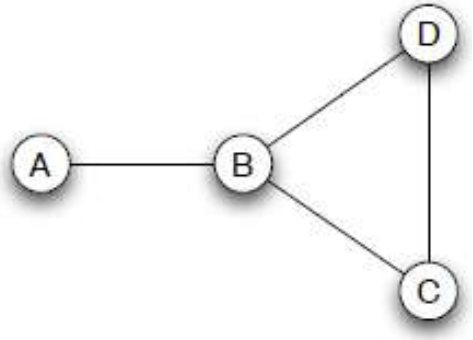
4-Node Path

- Node B have some amount of power over A, but it is a weaker kind of power than in the 3-node path
- In A-B exchanges, B gets roughly between 7/12 and 2/3 of the money

5-Node Path

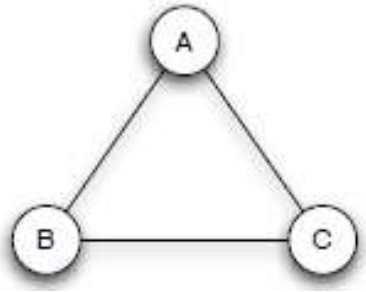
- Node C, which intuitively occupies the “central” position in the network, is in fact weak
  - Nodes B and D have very attractive alternatives
- In experiments, C does slightly better than A and E
- Simple centrality notions like betweenness can be misleading measures of power

Stem Graph



- Nodes C and D typically exchange with each other
- Node B exchanges with A, with favorable terms

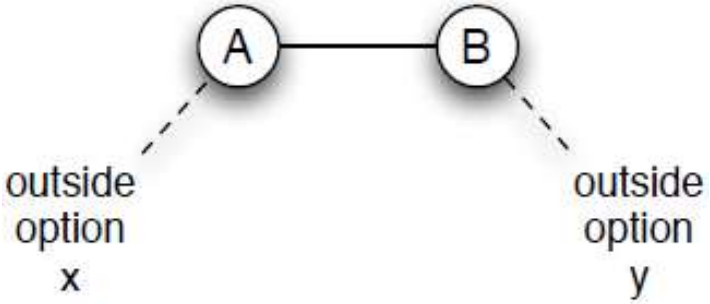
Unstable Network



- One node will always be left out
  - This node will be willing to break the others two negotiaton until the end with very favorable exchanges

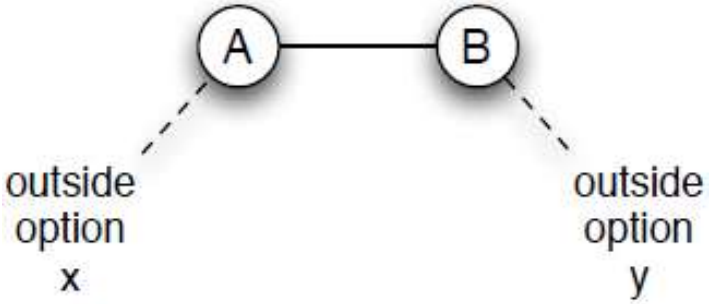
Modeling Two-Person Interaction

Nash Bargaining Solution



- Two nodes negotiating over how to split a value between them
- If a node doesn't like his share, he can leave and take his outside option
- Assume that the sum of the outside options is less than or equal to 1

Nash Bargaining Solution



- Node A requires at least x
- Node B requires at least y
- There will remain a surplus
- If A and B have equal bargaining power
  - The surplus is evenly splited

Nash Bargaining Solution

Nash Bargaining Solution: When A and B negotiate over splitting a dollar, with an outside option of x for A and an outside option of y for B (and $x + y \leq 1$), the Nash bargaining outcome is

- $x + \frac{1}{2}s = \frac{x + 1 - y}{2}$ *to* A, *and*
- $y + \frac{1}{2}s = \frac{y + 1 - x}{2}$ *to* B.

- One is depending equally on the other for concessions to make the negotiation work
- Trying to ensure an outside option as strong as possible, before the negotiations even begin, can be very important for achieving a favorable outcome

The Ultimatum Game

(i) Person A is given a dollar and told to propose a division of it to person B. That is, A should propose how much he keeps for himself, and how much he gives to B.

(ii) Person B is then given the option of approving or rejecting the proposed division.

(iii) If B approves, each person keeps the proposed amount. If B rejects, then each person gets nothing.

- Extreme power imbalance
- Human behavior will systematically deviate from extreme predictions of simple theoretical models

Modeling Network Exchange

Stable Outcomes

Outcome:

- a matching on the set of nodes specifying who exchanges with whom
- a value associated with each node, indicating how much the node gets from the exchange

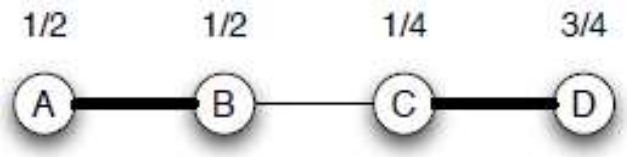
Stability:

- no node X can propose an offer to some other node Y that makes both X and Y better of

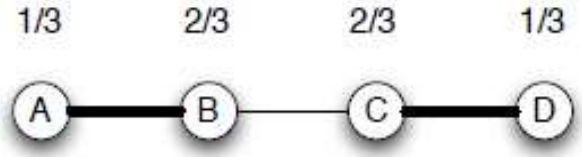
Stable Outcomes

Instability:

- an edge not in the matching, joining two nodes X and Y , such that the sum of X's value and Y 's value is less than 1



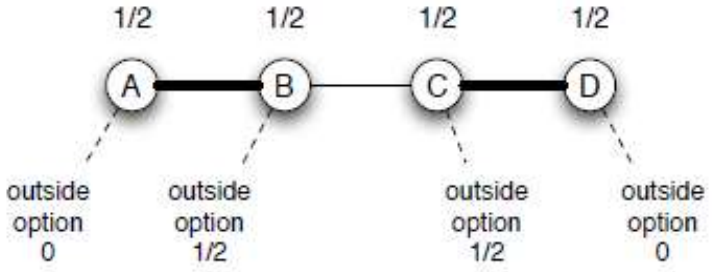
(c) *Not a stable outcome*



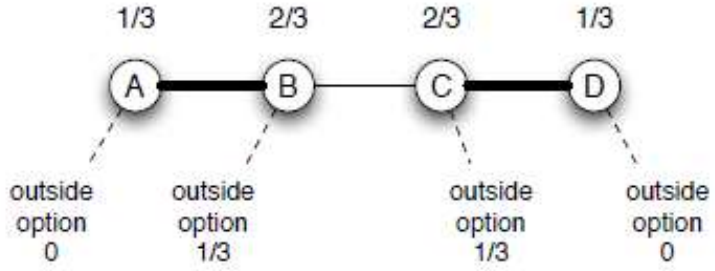
(e) *A stable outcome*

Balanced Outcomes

For each edge in the matching, the split of the money represents the Nash bargaining outcome for the two nodes involved, given the best outside options for each node provided by the values in the rest of the network.

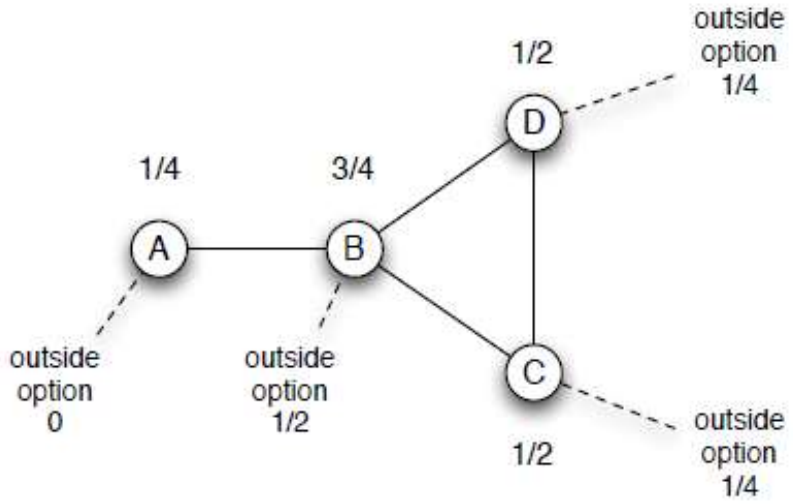


(a) *Not a balanced outcome*



(b) *A balanced outcome*

Balanced Outcomes



- Every balanced outcome is stable.
- In any network with a stable outcome, there is also a balanced outcome.
- Corresponds to the results of experiments with human subjects.

Bibliography

- David Easley and Jon Kleinberg. Networks, Crowds, and Markets: Reasoning About a Highly Connected World
  - Chapter 12 (12.1-12.3 and 12.5-12.8)